Assessing a hydrogeologic classification system in mid-Atlantic Coastal Plain streams using benthic macroinvertebrates.

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Introduction

- Nonpoint-source pollution, including pesticides and other toxic substances, is one of the largest threats facing aquatic resources today.
- The Landscape Indicators for Pesticides Study for mid-Atlantic Coastal Streams (LIPS-MACS), conducted jointly by USEPA and USGS, provides a landscape-based sampling design to efficiently estimate the condition of streams with respect to pesticides, nutrients, and other chemicals.
- A hydrogeologic classification system was developed for the LIPS-MACS region to better understand the natural processes controlling the quantity and quality of water in headwater streams.
- Development of stream macroinvertebrate indicators for LIPS-MACS requires an assessment of the natural variability of the macroinvertebrate assemblage across the study area.

Objectives

- Determine whether natural variability of the macroinvertebrate assemblage is described by the LIPS-MACS hydrogeologic classification system.
- Determine whether reach-scale factors help explain variation in macroinvertebrate assemblage structure.

LIPS-MACS Study Design

Population = 10,144 1st-order watersheds for freshwater streams

↓

Determine land use for each watershed

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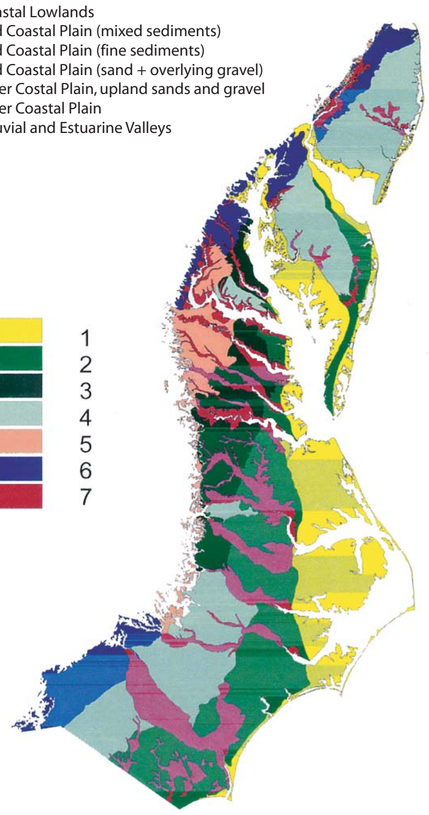
Sample = 25 watersheds selected across the developed (agriculture + urban) land use gradient in each of 7 hydrogeologic regions (n = 175)

Hydrogeologic Framework

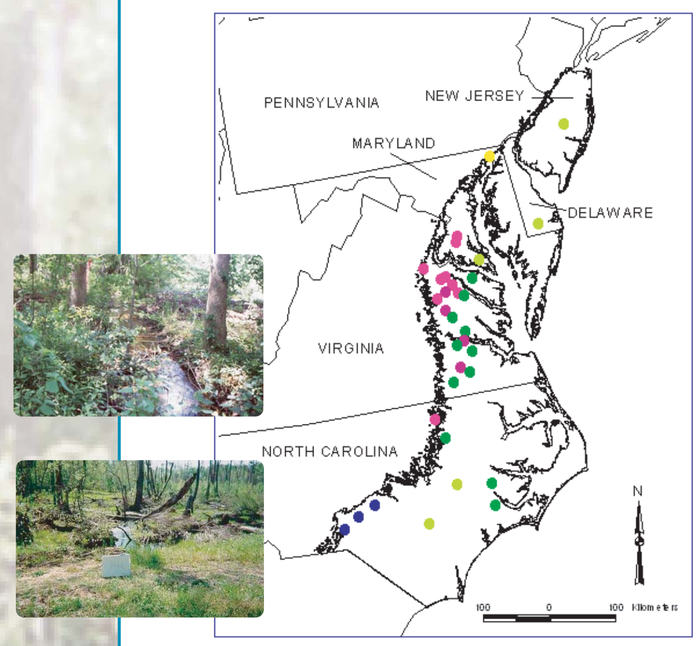
A hydrogeologic framework was developed that combines surficial geology and physiographic setting to delineate 7 distinct subregions within the Coastal Plain.

1) Coastal Lowlands
2) Mid Coastal Plain (mixed sediments)
3) Mid Coastal Plain (fine sediments)
4) Mid Coastal Plain (sand + overlying gravel)
5) Inner Costal Plain, upland sands and gravel
6) Inner Coastal Plain
7) Alluvial and Estuarine Valleys



Study Sites

Least-impacted LIPS-MACS study sites (n=33). Different colors represent different hydrogeologic regions.



Macroinvertebrate Sample Collection and Processing

- Streams sampled during late winter to early spring 2000
- Protocol: EMAP Wadeable streams protocol (EPA/620/R-94/004F)
- Nine samples collected with a modified kick net (595/600µm mesh) in riffle and pool habitats
- Samples composited into one riffle and one pool sample per site
- 300 organisms identified to genus-species

Analytical Approach

- Examined macroinvertebrate assemblages in least impacted streams.
- Least-impacted streams criteria:
  - Dissolved oxygen >= 4.0 mg/L
  - pH >= 4.5
  - Chloride < 10 mg/L
  - Mid-Atlantic Coastal Streams Habitat Score >= 105
- 33 least-impacted streams selected
- Used species occurring in >= 3 streams
- 166 species selected
- Multivariate Analyses
  - Multi-response permutation procedure
  - Ordination (non-metric multidimensional scaling)
  - Cluster analysis (Flexible Beta = -0.25)
- Analyzed macroinvertebrate presence/absence
- Distance measure: Sorensen

Results

Multi-response Permutation Procedure

Do macroinvertebrate assemblages differ significantly among hydrogeologic regions?

No, p = 0.239

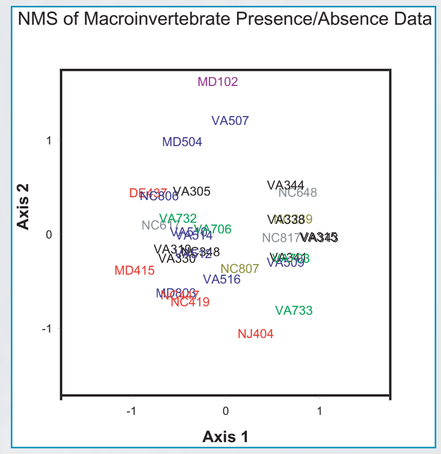
Caveat: Only 5 of the 7 regions analyzed because 2 had < 3 sites.

Non-metric Multidimensional Scaling

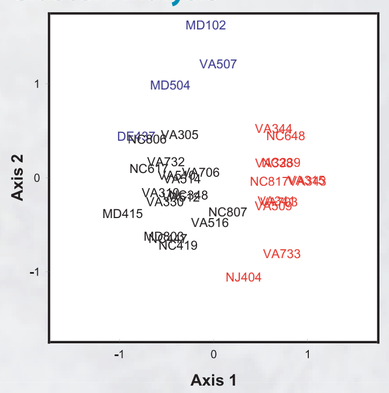
Axis 1: 23.8% variation explained; p = 0.05
Axis 2: 25.8% variation explained; p = 0.05

Sites with same color are in same hydrogeologic region.

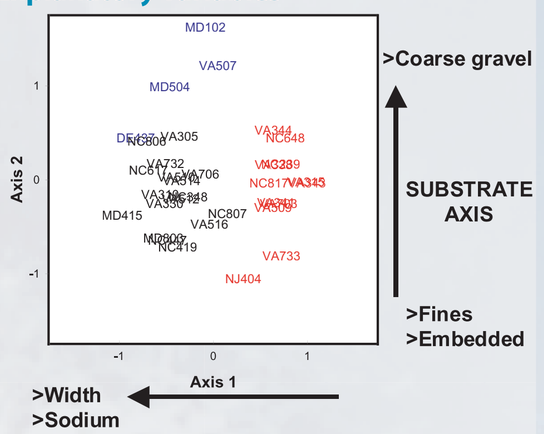
No clear pattern with respect to the hydrogeologic framework.



Cluster Analysis



Explanatory variables



Cluster analysis revealed three groupings of macroinvertebrates:

- o Blue-presence of stoneflies (e.g., *Haploperla*, *Amphinemura*)
- o Red-presence of amphipods (e.g., *Crangonyx taris*, *C. obliquus-richmondensis* complex), isopods (e.g., *Caecidotea* sp), chironomids (e.g., *Cricotopus bicinctus*, *Cladopelma* sp.)
- o Black-mostly chironomids (e.g., *Ablabesmyia mallochi*, *Meropelopia* sp., *Micropsectra* sp., *Polypedelium illinoense* gr., *Tribelos jucundum*), Pea mussels (*Pisidium* sp.), black flies (e.g., *Simulium venustum/verecundum* complex), Tubificidae

Axes correlated mostly with local, in-stream factors. Increased width appears to be associated with multiple-channels in reach, not necessarily more discharge.

Summary and Conclusions

- Macroinvertebrate assemblages do not correspond well to the hydrogeologic regions (unlike concurrent LIPS-MACS research examining stream chemistry).
- Least-impacted streams in the mid-Atlantic Coastal Plain are difficult to find.
- Local factors such as substrate and stream reach morphology were more influential for invertebrates than the landscape classification system. This agrees with findings of a recent series of JNABS papers summarized by Hawkins et al. (2000; JNABS 19:541-556).
- Macroinvertebrate indicators can be developed for first-order streams in the entire mid-Atlantic Coastal Plain, but caution must be applied due to relatively low sample size, especially in some hydrogeologic regions (e.g., coastal lowlands). Development of macroinvertebrate indicators for LIPS-MACS that are related to landscape condition and pesticides will need to consider important habitat variables to be successful.

Prepared by CSC Inc. for ORD/NERL/Cincinnati, Ohio - May 2002